CLAIMS

What is claimed is:

1. A method for detecting misfires of cylinders of a reciprocating internal combustion engine, the method comprising the steps of:

acquiring a series of acceleration data representative of acceleration behavior of the reciprocating engine;

sampling the data to obtain acceleration data samples at a rate sufficient to obtain up to fourth-order perturbations of the acceleration data;

filtering the samples to provide bandwidth limited samples;

providing the samples to at least two channels;

pattern matching the samples in the first channel to enhance harmonic phenomena and reduce random phenomena;

pattern canceling the samples in the second channel to enhance random phenomena and reduce harmonic phenomena; and

detecting misfires dependent on a magnitude of the filtered acceleration data samples.

2. A method in accordance with claim 1, further comprising a step of correcting the samples using a fueled correction and a non-fueled correction.

3. A method in accordance with claim 1, further comprising a second filtering step for each channel, wherein the second filtering step includes highpass filtering the samples non-linearly to reduce signals less than order 0.5.

4. A method in accordance with claim 1, further comprising the step of calculating acceleration from velocity information using a central difference algorithm.

5. A method in accordance with claim 1, further comprising the step of weighting and integrating the acceleration samples over an arbitrary crankshaft rotational angle of any width including fractional samples.

6. A method in accordance with claim 5, including a substep of decimating the samples to a lower rate that is not necessarily an integer factor of the sample rate utilizing linear interpolation.

7. A method in accordance with claim 1, wherein the detecting step includes shifting time-weighted trimmed-median acceleration samples from a sorted center value to one of an average and median value dependent upon detected misfires.

8. A method in accordance with claim 1, wherein the providing step includes providing three channels and the pattern matching step includes pattern matching cyclically sampled data to enhance detection of hard misfires in the first channel an using different pattern matching for sampled data to enhance detection of multiple misfires in the third channel.

9. A method in accordance with claim 1, wherein a separate finite-impulse response filter is provided in each channel.

10. A method in accordance with claim 1, wherein the sampling step includes determining one or more of the group of: work, power, torque, and indicated mean effective pressure (IMEP).

11. A method for detecting misfires of cylinders of a reciprocating internal combustion engine, the method comprising the steps of:

acquiring a series of acceleration data representative of acceleration behavior of the reciprocating engine;

oversampling the data to obtain acceleration data samples at a rate sufficient to obtain up to fourth-order perturbations of the acceleration data;

correcting the samples using a fueled correction and a non-fueled correction;

filtering the samples with a variable order finite-impulse response to provide bandwidth limited samples;

providing the samples to at least two channels;

highpass filtering the samples non-linearly in each channel;

pattern matching the samples in the first channel to enhance harmonic phenomena and reduces random phenomena for detecting hard misfires;

pattern canceling the samples in the second channel to enhance random phenomena and reduces harmonic phenomena for detecting random misfires; and

detecting misfires dependent on a magnitude of the filtered acceleration data samples.

12. A method in accordance with claim 11, wherein the second filtering step filters each channel to reduce signals less than order 0.5.

13. A method in accordance with claim 11, further comprising the step of calculating acceleration from velocity samples using a central difference algorithm at each sample that takes a difference between an earlier velocity sample and a later velocity sample.

14. A method in accordance with claim 11, further comprising the step of weighting and integrating the acceleration samples over an arbitrary crankshaft rotational angle of any width including fractional samples and decimating the samples to a lower rate that is not necessarily an integer factor of the sample rate utilizing linear interpolation

15. A method in accordance with claim 11, wherein the detecting step includes shifting time-weighted trimmed-median acceleration samples from a sorted center value to one of an average and median value dependent upon detected misfires.

16. A method in accordance with claim 11, wherein the providing step includes providing three channels and the pattern matching step includes pattern matching cyclically sampled data to enhance detection of multiple misfires in the third channel.

17. A misfire detection system for a reciprocating internal combustion engine, the system comprising:

acceleration measurement means for acquiring a series of acceleration data representative of acceleration behavior of the reciprocating engine;

means for sampling the data to obtain acceleration data samples at a rate sufficient to obtain up to fourth-order perturbations of the acceleration data;

means for filtering the samples to provide bandwidth limited samples;

means for pattern matching the samples to enhance harmonic phenomena over random phenomena;

means for pattern canceling the samples in the second channel to enhance random phenomena over harmonic phenomena; and

means for detecting misfires dependent on a magnitude of the filtered acceleration data samples.

18. A system in accordance with claim 17, further comprising means for weighting and integrating the acceleration samples over an arbitrary crankshaft rotational angle of any width including fractional samples.

19. A system in accordance with claim 18, including means for decimating the samples to a lower rate that is not necessarily an integer factor of the sample rate utilizing linear interpolation.

20. A system in accordance with claim 17 wherein the means for detecting include means for shifting time-weighted trimmed-median acceleration samples from a sorted center value to one of an average and median value dependent upon detected misfires.

21. A system in accordance with claim 17, wherein the means for pattern matching include a separate pattern matching for the sampled data to enhance detection of multiple misfires.

22. A system in accordance with claim 17, wherein the means for sampling included determining one or more of the group of: work, power, torque, and indicated mean effective pressure (IMEP).